MICROMACHINED ACTIVE MAGNETIC REGENERATOR FOR LOW TEMPERATURE MAGNETIC COOLERS

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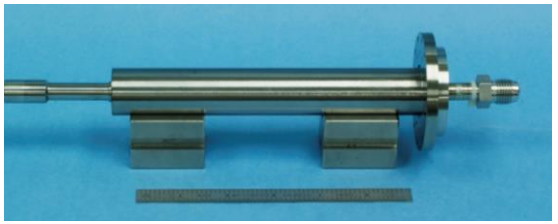
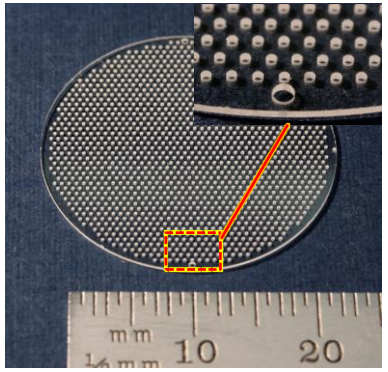
Objective

- A vibration-free, lightweight, efficient 2 K Active Magnetic Regenerative Refrigeration (AMRR) system.
- Reliable microfabrication process for microchannels in Gadolinium Gallium Garnet (GGG) disks.
- Advanced channel configuration in Micromachined Active Magnetic Regenerator (MAMR) for high thermal effectiveness and low pressure drop.
- Robust support structure for GGG stack to enable GGG disks to withstand launch vibrations and magnetic force during normal operation.



Assembled MAMR



GGG Disk with Uniform Micro Holes

Overall Micromachined Active Magnetic Regenerator Assembly and One of Its Micromachined Gadolinium Gallium Garnet (GGG) Plates.

Accomplishments

- Identified a unique, reliable microfabrication process that can machine very uniform microchannels with a diameter of about 250 microns in very brittle GGG disks.
- Devised an anisotropic regenerator core configuration to enhance uniformity of flow distribution, reduce axial heat conduction, and reduce dead volume.
- Verified robustness of regenerator structural design by vibration testing.
- Demonstrated regenerator core thermal and fluid performance by separate effects testing.
- Developed reliable MAMR assembly approach.
- Assembled a prototype MAMR with 150 micromachined GGG plates, which can lead to a predicted COP of 42% of Carnot cycle for integrated AMRR.

$TRL_{in} = 3$ $TRL_{out} = 4$